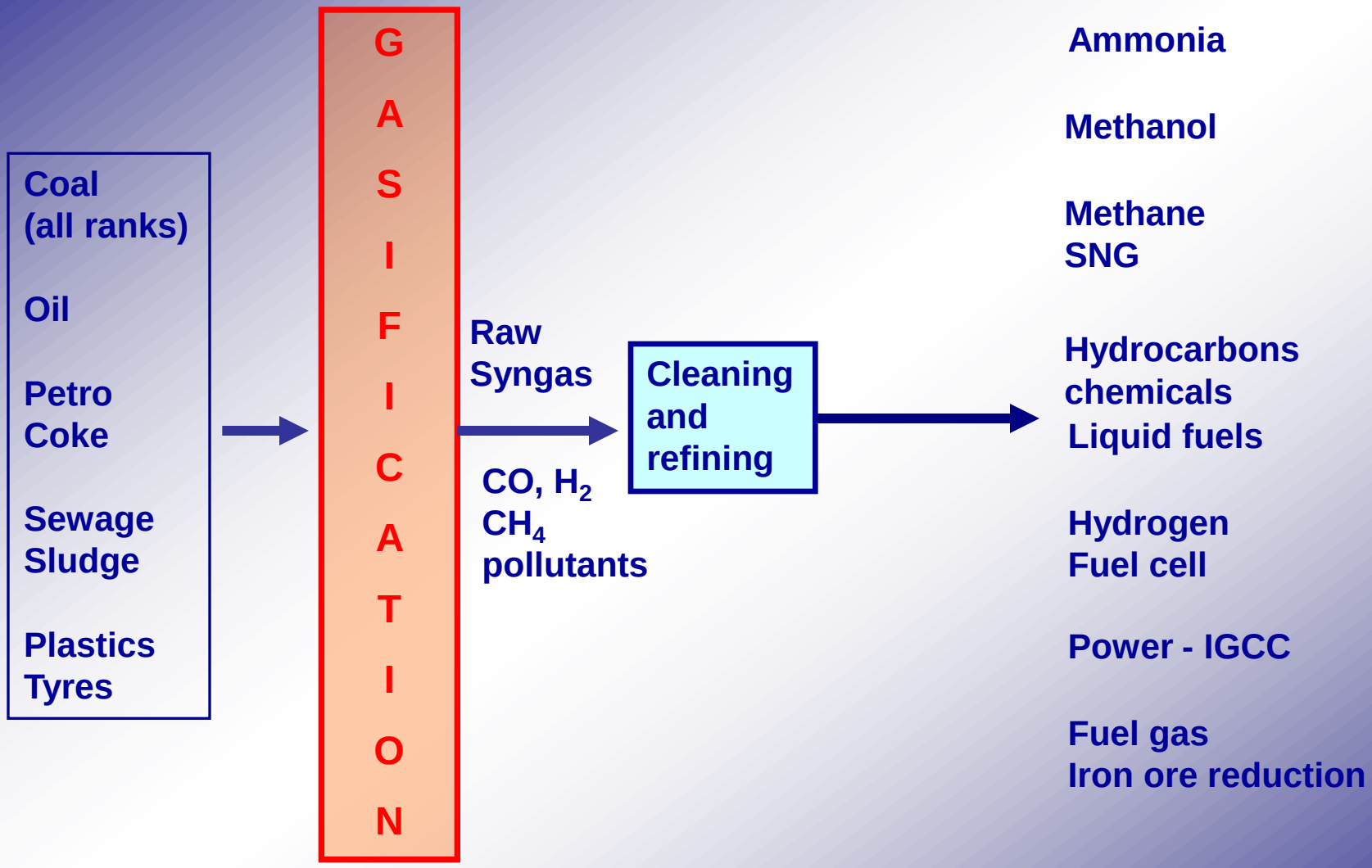
Coal Gasification

Sankar Bhattacharya

Energy Technology Collaboration Division
International Energy Agency, Paris

International Seminar
Brazilian Coal Association – ABCM and International Energy Agency
Brasilia, June 27, 2007

What is Gasification



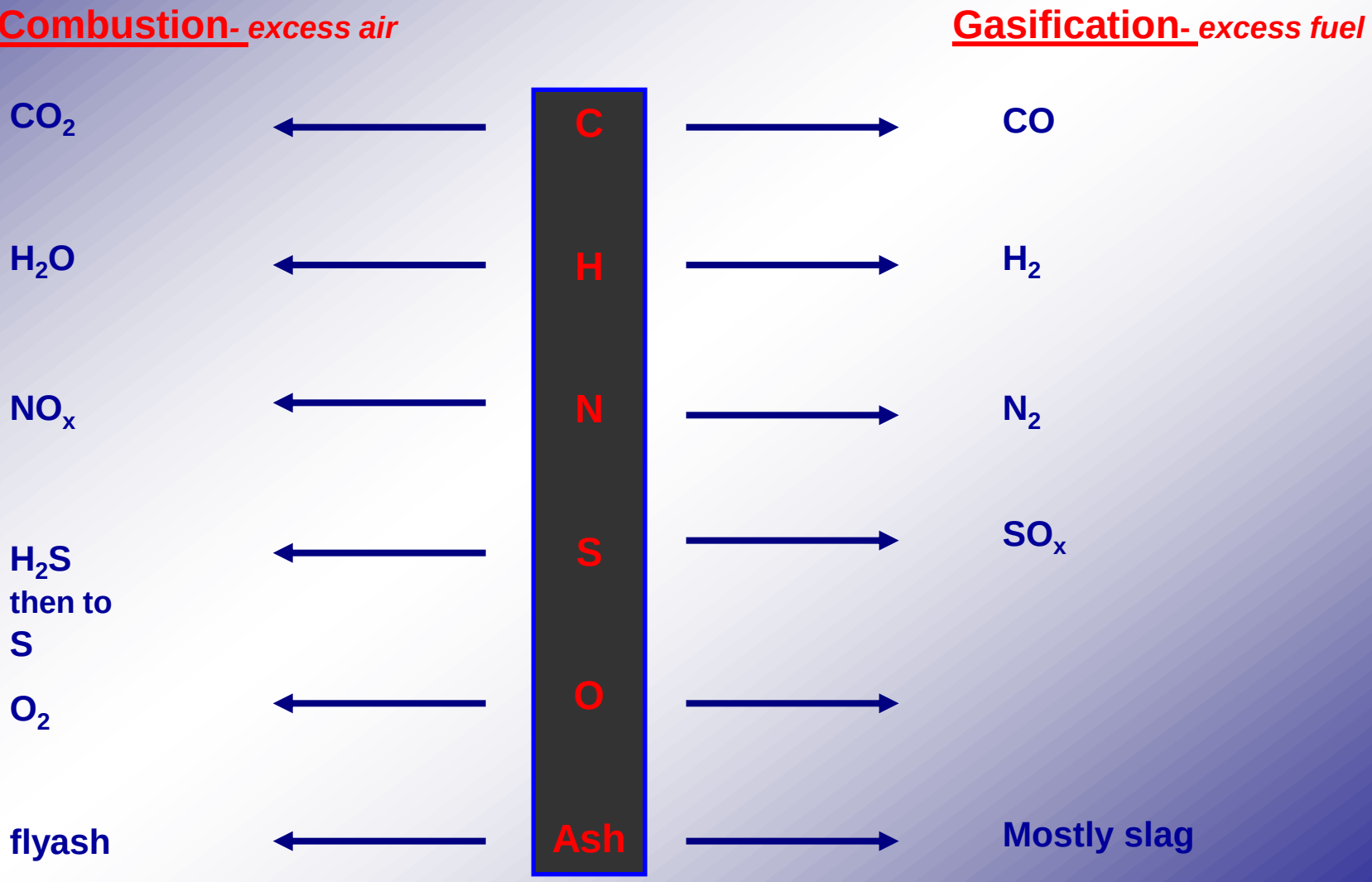
Gasification is not new, practiced in various forms since 1792….

What is Coal

- Carbon
- Hydrogen
- Sulfur
- Oxygen
- Nitrogen
- Ash
- Water

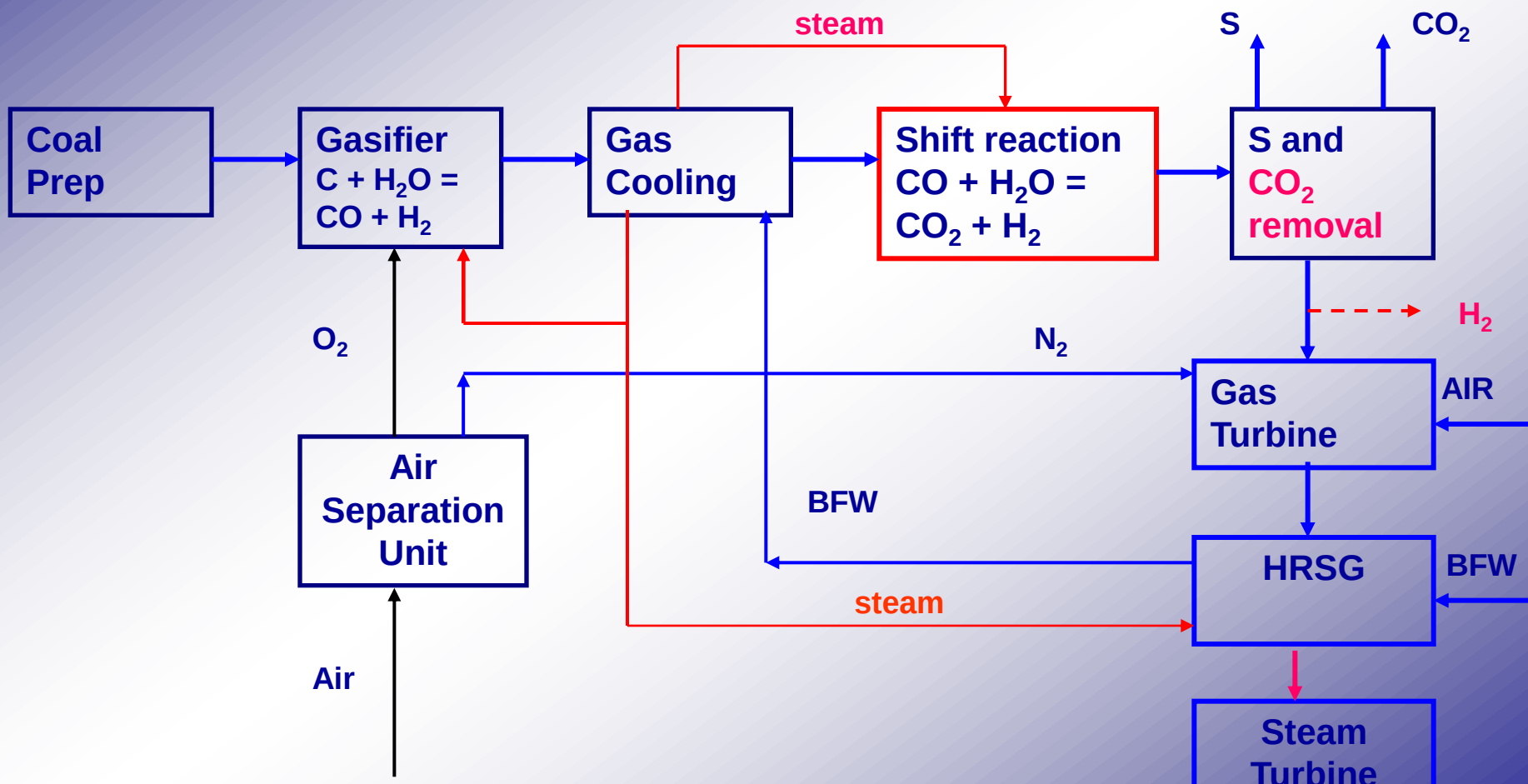
Coal Gasification

…how it differs from combustion…



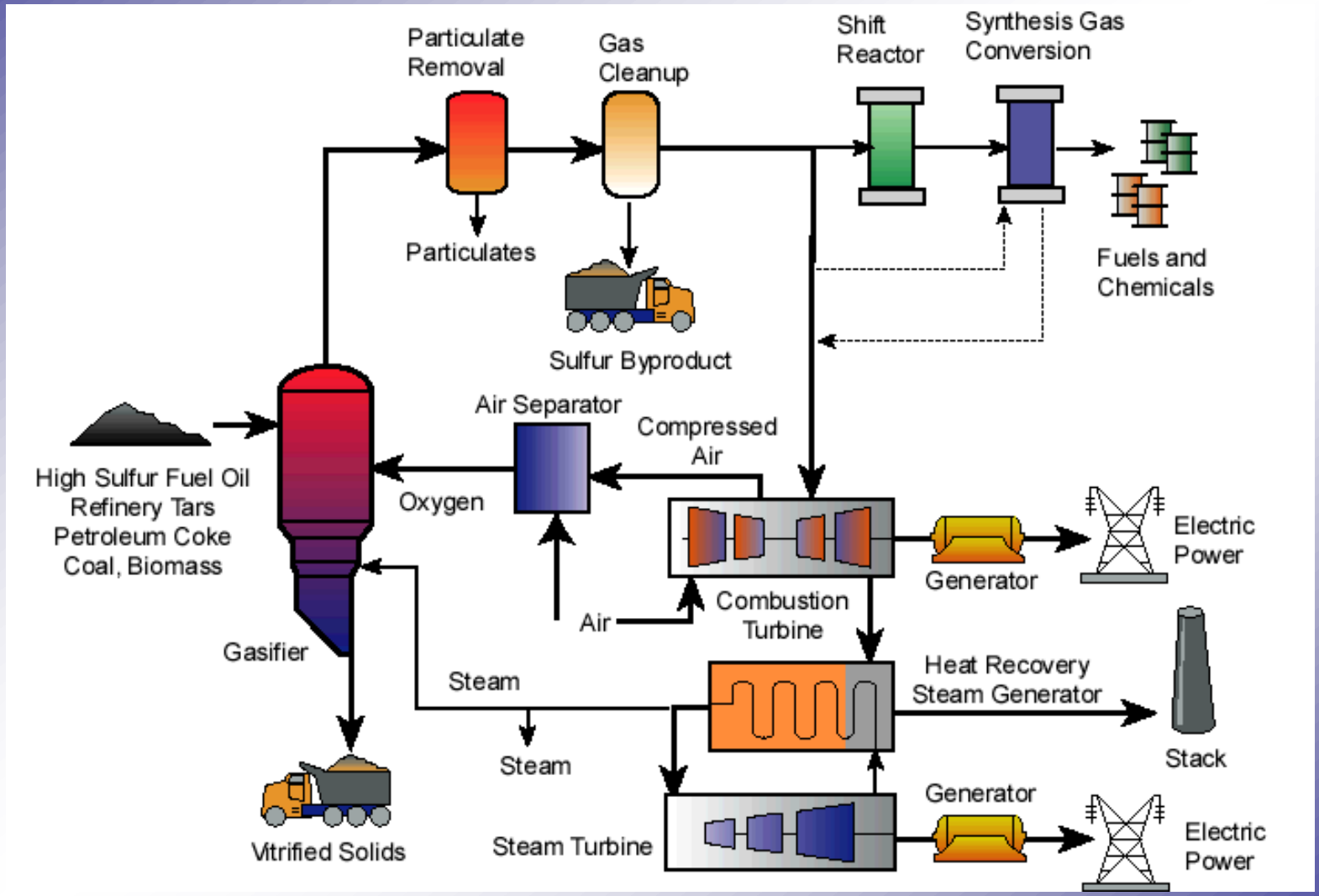
Coal Gasification

…..a means for co-production of power, fuels and chemicals….



Note: energy in the C in coal is used to generate H_2 from water, and coal
Co-production of power and H_2 – base for subsequent chemicals production

Coal Gasification

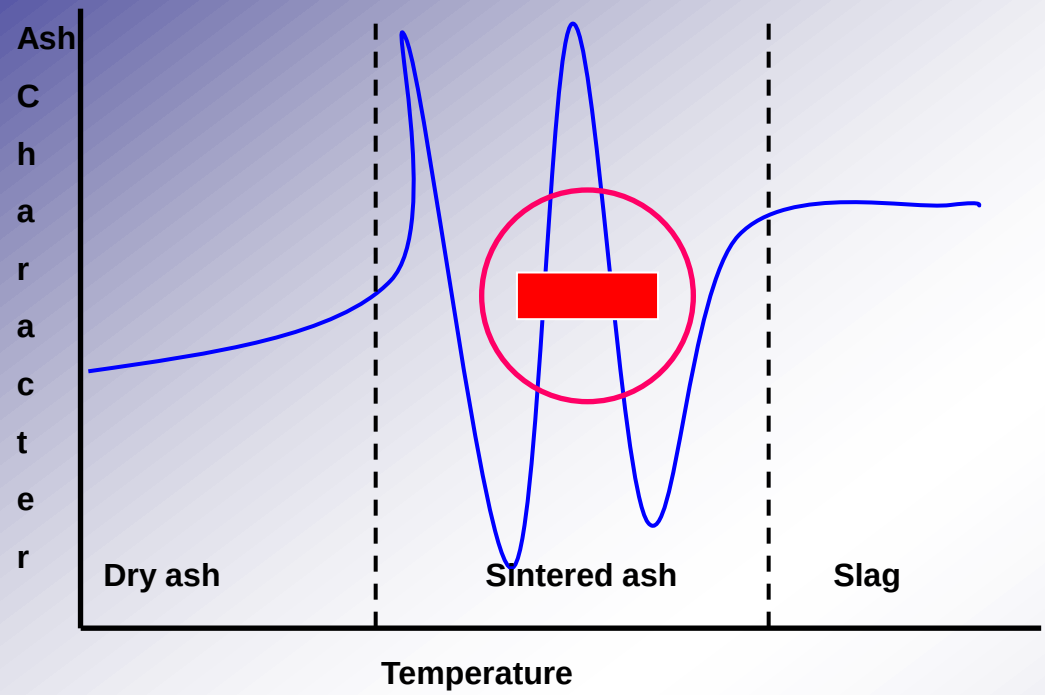


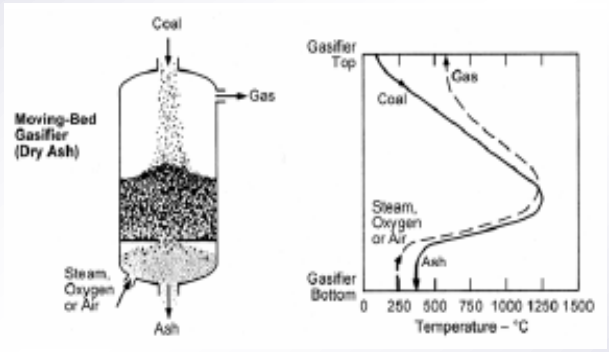
www.gasification.org

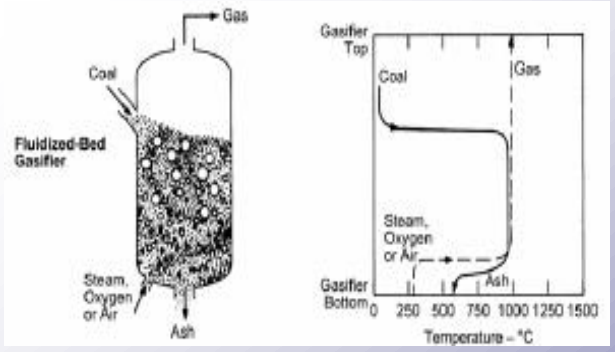
Gasification – *summary of environmental impacts*

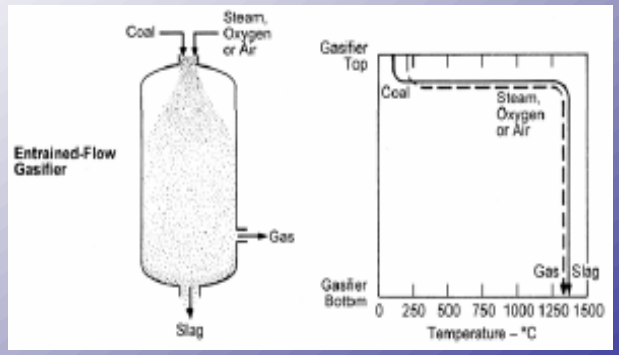
- CO_2 in a concentrated and pressurized form – more amenable to capture
- No So_x, S is in the form of H_2S, can be captured as a S-byproduct
- Little NOx compared to combustion, below acceptable limits
- Particulate emission within permissible limits
- Heavy organics within acceptable limits
- Coal ash mostly glassy, trace elements confined into slag into a non-leachable form
- Mercury, if present in coal, can be captured using activated carbon bed
- Gasifier temperature destroys Furans and Dioxins, if formed
- Up to 25% less water usage than supercritical *pf* power plants

Types of Coal Gasifiers









Air or O_2 blown
Steam –may or may not be required

Christiansen, 1996; IEACCC report

Coal Gasification – Current Status

Early large plants .. 250 MW class – mainly for power

Puertollano – Spain; Shell (Prenflo)

Buggenum – Netherlands; Shell

Wabash – USA; ConocoPhilips (E-Gas)

Polk – USA; GE (Texaco)

Both Dry and Slurry feeding……

Coal Gasification – Current Status

Early large plants ….. mainly for chemicals production

Great Plains Synfuel Plant North dakota
http://www.dakotagas.com/Companyinfo/index.html

Uses Lignite

Fertilizers
NH_3 for chemicals
Pesticides
Solvent
Resins
Naphtha
Liquid N_2

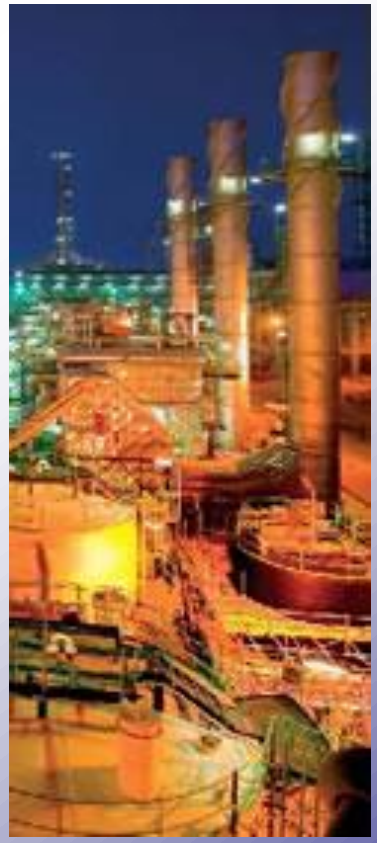
CO_2

Weyburn pipeline
http://www.ptrc.ca/access/DesktopDefault.aspxhttp

2.7 MT per year
For EOR

Uses variety of coals

Olefins
Polymers
Solvent
Wax
Auto fuels
Degreasers
Grease
Lubricant
Fuel oil
Phenol



Sasol – ***since 1955***
http://sasol.quickreport.co.za/sasol_ar_2005/index.htm

Coal Gasification – Current Status

Several key players active in coal gasification …..

➢ **General Electric – a major player in gas and steam turbines**

- **3 plants start-up in China in 2005-06 – coal-to-ammonia and methanol**
- **4 license agreements in China to work on coal-to-ammonia projects**

- **American Electric Power IGCC, Ohio – Commercial start-up in 2012**
- **American Electric Power IGCC, West Virginia – Commercial start-up in 2011**
- **Duke Energy IGCC, Indiana - Commercial start-up in 2011**

- **GE – BP, BP-Rio Tinto Joint Venture in Hydrogen Energy, GE-Bechtel tie-up for turnkey gasification offering**

- **Last week's acquisition of Stamet Pumps – a significant boost for their offering now into the sub-bituminous to low-moisture lignites**

Coal Gasification – Current Status

- **Siemens – a major player in gas and steam turbines**
  - Acquired Future Energy gasification – suitable for bituminous and lignites
  - Confirmed contracts for six 200-500 MW projects in China – coal-to-methanol and coal-to-ammonia
  - Siemens-Fluor tie-up for turnkey gasification offering
- **Shell – a major player in coal and petro-chemicals**
  - 15 coal gasification projects in China - coal-to-methanol and coal-to-ammonia
  - JV agreements in Australian gasification projects
  - Tie-up with Krupp UHDE, and Black & Veatch for turnkey IGCC offering
- **Conoco Phillips**
  - 606 MW IGCC for Excelsior Energy in Minnesota
  - Tie-up with Fluor for turnkey gasification offering

Coal Gasification – Current Status

➢**Southern Company**

- **285 MW proprietary transport reactor based IGCC in Orlando**
- **Supported by the US Government under its CCPI Round 2 funding**
- **Tie-up with KBR for design services**

Formation of these tie-ups – reduce front end engineering and development costs - Reduce the IGCC risks

Coal Gasification – Current Status

…other major players…

- **Sasol, South Africa**
  - **contracts signed for feasibility studies for coal-to-liquids projects in China and India**

- **Mitsubishi, Japan - a major player in turbines**
  - **developing gasifier of its own**
  - **building a 250 MW IGCC plant in Japan**

- **Hitachi**
- **J-Power**

Significantly improved IGCC potential due to the involvement of the top power industry vendors + some with state-of-the art GT + strong financial muscle

R&D requirements for Brazilian Coal

- **Indigenous R&D capacity building – for Brazilian conditions and Brazilian coal properties – technology developed for coals elsewhere may not be directly applicable without tweaking**

- **Proper estimation of coal resource and coal/ash characterization**

- **Reducing ash content is key to utilization via gasification**
  - **Washability characteristics – yield, and yield improvement**
  - **Characterization of washery rejects**
  - **Use in CFBC for maximum energy extraction**

- **Gasification characteristics of parent coal and washed coal**
  - **entrained flow vs. fluidized bed gasification**
  - **C-conversion, gas composition**
  - **extent of pollutant emission – gaseous and solids**
  - **characterization of solid wastes**
  - **any ash related problems?**

….by no means complete…..

R&D requirements for Brazilian Coal

- **Indigenous research centre – coordinated closely with the coal industry and the government – not working in isolation on academic research only**

- **Focusing on practical issues – coordinated with the users of the entire fuel chain – geological sector, coal mining industry and coal utilities**

- **In the process develop the skill base in R&D in the country – to cater for the need of the industry**

- **Development of Skill base in experimental area, modeling and analytical support**

- **Networking with other research centres and universities elsewhere in the world**

Does Coal Have a Role in Security of Supply?

Key to Risk Management
Diversification
Diversification
Diversification

Coal provides a much needed Diversity in the energy-mix

Coal's saving grace

- **Abundant and well dispersed unlike natural gas or oil**
- **Secure**
- **Relatively affordable**